

and a half millions has been the entire cost of the structure, of which £300,000 (nearly one-third of this amount) has been expended on plant and general charges. These figures will give you some idea of the magnitude of the work, and will assist you to realize the labour and anxiety which all those connected with it must have undergone. The works were commenced in April 1883, and it is highly to the credit of everyone engaged in the operation that a structure so stupendous and so exceptional in its character should have been completed within seven years. The opening of the bridge must necessarily produce important results and changes in the railway service of the east coast of Scotland, and it will, above all, place the valuable manufacturing and mineral-producing district of Fife in immediate communication with the south side of the Firth of Forth. When the Glenfarg line, now nearly completed, is opened for traffic, the distance between Edinburgh and Perth will be reduced from 69 to 47 miles, and instead of the journey occupying, as at present, two hours and 20 minutes, an express will be able to do it in an hour. Dundee, likewise, will be brought to within 59 miles of Edinburgh, and Aberdeen 130 miles, and no sea ferries will have to be crossed. The construction of the bridge is due to the enterprise of four important railway companies—(1) North British (the bridge is in its district), (2) North-Eastern, (3) Midland, and (4) Great Northern—and the design is that of two most eminent engineers, Sir John Fowler and Mr. Benjamin Baker. The contractor was Mr. William Arrol, and the present Tay Bridge, and the bridge which I have inaugurated to-day, will be lasting monuments of his skill, resources, and energy. I have much pleasure in stating that, on the recommendation of the Prime Minister, the Queen has been pleased to create Mr. Matthew William Thompson, Chairman of the Forth Bridge Company and of the Midland Railway Company, and Sir John Fowler, engineer-in-chief of the Forth Bridge, baronets of the United Kingdom. The Queen has also created, or intends to create, Mr. Benjamin Baker, Sir John Fowler's colleague, a Knight Commander of the Order of St. Michael and St. George, and to confer on Mr. William Arrol, the contractor, the honour of a knighthood. I must not allow this opportunity to pass without mentioning the valuable assistance which has been rendered to the companies by Mr. Wieland, their able and indefatigable secretary, who deserves especial praise for the admirable way in which he has carried out the important financial arrangements essential in a scheme of such magnitude. Before concluding I must express my pleasure at seeing here Major-General Hutchinson and Major Marindin, two of the inspecting officers of the Board of Trade. Although in this country great undertakings of the kind which we are celebrating this day are wisely wholly left to the enterprise and genius of private individuals without aid or favour from the State; yet, in connection with these particular works, Parliament, I am informed, for the first time associated officers of the Board of Trade with those practically engaged in the construction of this magnificent bridge from its commencement by requiring the Board of Trade to make quarterly reports to be laid before Parliament as to the nature and progress of the works. This most important and delicate duty has been performed by Major-General Hutchinson and Major Marindin; and I now congratulate them on the completion of their responsible duties, which they have carried out in a way that redounds credit to themselves and to the department which they so ably serve. Allow me again, gentlemen, in thanking you for the kind way in which you have received this toast, to assure you of the great pleasure and gratification it has been to me to have been present on this occasion to inaugurate this great success of the skill of engineering."

Sir John Fowler, in acknowledging the toast of the Forth Bridge, said he begged to return his most grateful thanks to His Royal Highness the Prince of Wales for the flattering manner in which he had spoken of their work. It was now seven years ago since the foundations of the bridge were commenced, but up to two years ago they had to endure not only the legitimate anxieties of their duties, but the attacks and evil predictions which were always directed against those who undertook engineering work of novelty or exceptional magnitude. It was very curious to watch the manner of retreat of these prophets of failure. The results had proved them to be mistaken. But he could tell some very curious stories connected with the bridge. He pointed out how, from the nature of the materials which had been used in the construction of the bridge, and from the na-

tionality of the men who had been engaged in that construction, the bridge possessed an international character. He also predicted that the bridge would last for many, many years, and he cordially acknowledged the workmanship and ability of all who had assisted in its erection. As to the workmen themselves, he said they had done admirable work, and had never knowingly scamped a rivet.

Mr. Arrol also acknowledged the toast, and Mr. Baker, in response to calls from the audience, made a few remarks.

Mr. John Dent, Deputy-Chairman of the Forth Bridge Railway Company, in proposing the toast of "The Guests," congratulated the recipients of the special honours bestowed by the Queen, and he spoke of the universal reputation which had become attached to the bridge, which stood as a monument of industry, of genius, and of ability.

After a clever speech from Lord Rosebery, Herr Mehrrens, of the Prussian Railway Department, replied for himself and in the name of his companions from Saxony, Austria, and Hungary. He expressed their feelings of thankfulness that they had been permitted to be present on so interesting an occasion, and their admiration at all the wonderful things they had seen that day. That day, he said, marked the commencement of a new era in iron bridge building. He congratulated Great Britain, which had led the way in iron bridge building, on now having the largest span bridge and the strongest bridge in the world.

M. Picot, on behalf of the railway engineers of France, also replied in a speech in which he eulogized the bridge and its engineers and contractors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies announce that they will this term appoint an additional Lecturer in Botany for three years, from the beginning of the Easter term 1890. The stipend is £100 a year. Names of candidates are to be sent to the Vice-Chancellor on or before March 8.

The Syndics of the Press propose that a gift of books published by them shall be made to the Library of the University of Toronto, lately destroyed by fire.

The discussion by the Senate of the proposal to accept the Newall telescope was on the whole favourable to the proposal, though the difficulty of finding the funds required for its adequate maintenance and use has not yet been made. From remarks made by members of the Observatory Syndicate, it appears that it regards the purchase of a large reflecting telescope as the first claim on the Sheepshanks Fund; and it is unwilling to deplete the fund until this purchase can be effected. Prof. Liveing referred to the recent development of astronomical physics, and said the University was bound to further it. The Newall telescope was specially suited for physical researches, and to reject it as a "white elephant" would damage the University by discouraging other benefactors. The matter is to be referred to the Financial Board.

At the meeting of the Philosophical Society on March 10, the following papers are promised:—W. Gardiner, on the germination of *Acacia sphaerocephala*; M. C. Potter, the thickening of the stem in Cucurbitaceæ; Dr. Lea and W. L. Dickinson, note on the action of rennin and fibrin-ferment; W. Bateson, on some skulls of Egyptian mummified cats.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 20.—"A Comparative Study of Natural and Artificial Digestions" (Preliminary Account). By A. Sheridan Lea, Sc.D., Fellow of Gonville and Caius College, Cambridge, University Lecturer in Physiology. Communicated by Prof. Michael Foster, Sec. R.S.

The objects of the investigation were (i.) to obtain in artificial digestions some closer approximation to the general conditions under which natural digestion is carried on in the body, and (ii.) to apply the improved methods of carrying on artificial digestions to the elucidation of some special differences, which so far have appeared to exist between the natural and artificial processes.

An apparatus was described by means of which digestions can be carried on in a dialyzer in such a way as to provide for the constant motion of the digesting mixture and the removal of digestive products: by this method a partial reproduction of two of the most important factors in natural digestion is provided.

So far the method has been employed for

I. *The salivary digestion of starch.* Experiments conducted under otherwise similar conditions in the dialyzing digester and a flask, showed that—(i.) The rate of digestion in the former is always greater than in a flask, and at the same time the tendency to the development of bacteria is greatly lessened. (ii.) The amount of starch converted into sugar is always greatest in the dialyzer. (iii.) The total sugar formed and small residue (4.29 per cent.) of dextrin left during an active and prolonged digestion in the dialyzer justify the assumption that, under the more favourable conditions existing in the body, the whole of the starch taken is converted into sugar before absorption.

The above results afford an explanation of the existing discordant statements as to the nature and amount of products formed during starch digestion.

II. *The tryptic digestion of proteids.* The experiments made dealt chiefly with the formation of leucin and tyrosin, and were undertaken, initially, in order to find out why these crystalline products are formed in large amount during an artificial digestion, while they have so far been described as occurring in mere traces during natural digestion. The results of the experiments made it probable that leucin and tyrosin should be formed during natural digestion. Examination of the contents of the small intestine during proteid digestion showed that, contrary to existing statements, leucin and tyrosin are formed in not inconsiderable quantities during the natural process.

The last part of the communication dealt with the probable physiological importance of the formation of amidated bodies during tryptic digestion, and a view was put forward as to the possible and probable importance of amides in the chemical cycle of animal metabolism.

The experiments are being extended to the pancreatic digestion of starch.

Linnean Society, February 20.—W. Carruthers, F.R.S., President, in the chair.—Mr. G. C. Druce exhibited specimens of *Agrostis canina*, var. *Scotica*, and a small collection of flowering plants dried after treatment with sulphurous acid and alcohol, and showing a partial preservation of the natural colours of the flowers.—Mr. F. P. Pascoe exhibited a series of Coleopterous and Lepidopterous insects to show the great diversity between insects of the same family.—The Right Hon. Sir John Lubbock, Bart., M.P., P.C., then gave an abstract of four memoirs which he had prepared: (1) on the fruit and seed of the Juglandiæ; (2) on the shape of the oak-leaf; (3) on the leaves of *Viburnum*; and (4) on the presence and functions of stipules. An interesting discussion followed, in which Mr. J. G. Baker, Mr. John Fraser, Mr. D. Morris, and Prof. Marshall Ward took part.

EDINBURGH.

Royal Society, February 17.—Sir W. Thomson, President, in the chair.—Prof. Crum Brown communicated a paper, by Mr. Tolver Preston, on Descartes' idea of space and Sir W. Thomson's theory of extended matter.—The following communications from the chemical laboratory of the University were read:—(a) Prof. Crum Brown, on a new synthesis of dibasic organic acids. The method proposed was the electrolysis of potassium ethyl salts of lower dibasic acids which would take place according to the scheme



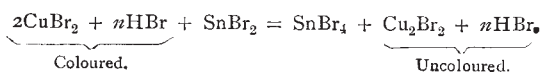
thus giving the diethyl ether of a higher acid of the same series. (b) Prof. Crum Brown and Dr. James Walker, on the electrolysis of potassium ethyl malonate, and potassium ethyl succinate. The reaction actually takes place in great measure in the above indicated sense, the yields of pure succinic ether and of adipic ether respectively being from 20 to 30 per cent. of the theoretically obtainable quantities. The method is thus proved to be of practical as well as of theoretical importance. (c) Dr. John Gibson, on the action of bromine and carbonate of soda in solutions of cobalt and nickel salts.—Mr. W. Calderwood read a paper on the swimming bladder and flying powers of *Dactylopterus volitans*.

PARIS.

Academy of Sciences, February 24.—M. Hermite in the chair.—The proofs of the separation of the south-east extremity of the Asiatic continent during recent times, by M. Émile Blanchard. The author advances proofs from the resemblance of animal and vegetable life in Further India, on the peninsula of Malacca, and Sunda Islands.—The *Dryopithecus*, by M. Albert Gaudry. The relation of *Dryopithecus* to the ape and to man has been investigated.—A contribution to the chemical study of the truffle, by M. Ad. Chatin. The researches have been directed to the quantitative determination of the organic and other matter in truffles.—Scrotal pneumocèles, by M. Verneuil.—On the anatomy and the physiological pathology of the retention of urine, by M. F. Guyon.—Transformations in kinematic geometry, by M. A. Mannheim.—On the constitution of the line spectra of elements, by M. J. R. Rydberg. This is a note on the periodic recurrence of doubles and triplets in the spectrum of an element. It is shown how this periodicity enables the spectrum of an element to be found by interpolation when the spectra of elements of the same group are known, the case of gallium being given as an example of the verification of the principle.—Electrical oscillations in rarefied air, without electrodes; demonstration of the non-conductivity of the vacuum, by M. James Moser. It is well known that vacuum-tubes become luminous when near an induction coil in action. The author, by enveloping one vacuum-tube with another, in which the rarefaction could be varied, finds that the excitation may take place without any electrode. If the pressure in the outer tube be equal to 760 mm., the inner tube, under the influence of the coil, becomes luminous and of a clear blue colour; if, however, the pressure be diminished to 1 mm. of mercury, the air in the outer tube becomes luminous and of a pronounced red colour, thus reversing the phenomena.—Upon the variation, with the temperature, of the bi-refractions of quartz, barytes, and kyanite, by MM. Er. Mallard and H. Le Chatelier. This variation has been studied by the aid of a photographic spectroscopic method: with quartz a singular point is detected at 570°, at which temperature the law of variation suddenly changes; a similar phenomenon is indicated as occurring in the case of kyanite somewhere between 300° and 600°.—The vapour-pressure of acetic acid solutions, by MM. F. M. Raoult and A. Recoura. It has been previously shown by one of the authors (*Comptes rendus*, May 23, 1887; *Annales de Chimie et de Physique*, 6th series, t. xv., 1888) that, if f represents the vapour-tension of a solvent for a certain temperature, f' the vapour-tension under similar conditions when a non-volatile body is in solution, P the weight of substance dissolved in 100 grms. of the solvent, M the molecular weight of the dissolved body, and M' the molecular weight of the solvent, then for dilute solutions—

$$K = \frac{100(f - f')}{f'P} \cdot \frac{M}{M'}$$

K being a constant generally near to unity. Employing the dynamical method, the mean value of K for acetic acid is found to be 1.61, taking 60 as the molecular weight of acetic acid; but if the molecular weight of a liquid be the same as that of the saturated vapour, the apparent anomaly disappears, for with molecular weight 97 (deduced from density of saturated acetic acid vapour at 118°, viz. 3.35), the above formula gives $K = 1$.—The action, in the dry way, of various arseniates of potassium and sodium upon the oxides of the magnesia series, by M. C. Lefèvre.—Note on the volumetric estimation of copper, by MM. A. Etard and P. Lebeau. A method of titration is given by the authors, for which they claim a rapidity and accuracy comparable to the permanganate method for iron; it is based upon the formation of a characteristic violet coloration on the addition of concentrated hydrobromic acid to a solution of the copper salt, and the subsequent decoloration of the solution by standardized stannous chloride solution containing much hydrochloric acid; thus—



—Preparation of hydroxycamphocarboxylic acid from camphocarboxylic acid, by MM. A. Haller and Minguin.—Upon the organization of left-handed Prosobranchiate Gastropoda (*Neptunea contraria*, Linnæus), by MM. P. Fischer and E. L. Bouvier.—

Upon the initial cells of the ovary in fresh-water Hydræ, by M. Joannes Chatin.—Note on a new putrefaction ptomaine, obtained by the culture of *Bacterium alii*, by Mr. A. B. Griffiths. The author gives analyses of an alkaloid, produced by the decomposition of albuminoids by this organism, showing it to belong to the hypopyridine series, and to possess the formula of hydrocoridine, $C_{10}H_{17}N$.—On the chromogenous functions of the pyocyanic bacillus, by M. C. Gessard.—Fossil Radiolarians inclosed in albite crystals, by M. A. Issel. The author concludes from the data given—(1) that a sedimentary fossiliferous rock has become crystalline and rich in plagioclastic crystals, without the stratification being sensibly altered; (2) that this change has been produced in a Tertiary formation; (3) that a hydrothermal action is indicated.—A contribution to the history of chrome-iron, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—On a Second Case of the Occurrence of Silver in Volcanic Dust—namely, in that thrown out in the Eruption of Tunguragua, in the Andes of Ecuador, January 17, 1886: Prof. J. W. Mallet, F.R.S.—On the Tension of Recently-formed Liquid Surfaces: Lord Rayleigh, Sec.R.S.—(1) On the Development of the Ciliary or Motor Oculi Ganglion; (2) The Cranial Nerves of the Torpedo (Preliminary Note): Prof. J. C. Ewart.

LINNEAN SOCIETY, at 8.—On the Production of Seed in some Varieties of the Common Sugar-Cane. (*Saccharum officinarum*): D. Morris.—An Investigation into the True Nature of Callus; Part I, the Vegetable Marrow, and *Ballia callitricha*: Spencer Moore.

ROYAL INSTITUTION, at 3.—The Early Developments of the Forms of Instrumental Music: Frederick Niecks.

FRIDAY, MARCH 7.

PHYSICAL SOCIETY, at 5.—On Bertrand's Refractometer: Prof. S. P. Thompson.

GEOLOGISTS' ASSOCIATION, at 8.—On some Pleistocene (non-Marine) Molusca of the London District: B. B. Woodward.—Notes on some Pleistocene Sections, in and near London: W. J. Lewis Abbott.—Note on a Curious Appearance produced by the Natural Bisection of some Spherical Concretions in a Yoredale Stone Quarry near Leek: Dr. Wheelton Hind.

INSTITUTION OF CIVIL ENGINEERS, at 7.30.—Telephonic Switching: C. H. Worthingham.

ROYAL INSTITUTION, at 9.—Electrical Relations of the Brain and Spinal Cord: Francis Gotch.

SATURDAY, MARCH 8.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—Electricity and Magnetism: Right Hon. Lord Rayleigh, F.R.S.

SUNDAY, MARCH 9.

SUNDAY LECTURE SOCIETY, at 4.—Pasteur, and his Discoveries (with Oxyhydrogen Lantern Illustrations): Sir Henry E. Roscoe, M.P., F.R.S.

MONDAY, MARCH 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—On Lieut. H. B. Vaughan's Recent Journey in Eastern Persia: Major-General Sir Frederic J. Goldsmid, K.C.S.I.

VICTORIA INSTITUTE, at 8.—On the Monism, Pantheism, and Dualism of Brahmanical and Zoroastrian Philosophers: Sir M. Monier-Williams, K.C.I.E.

TUESDAY, MARCH 11.

SOCIETY OF ARTS, at 8.—The Claims of the British School of Painting to a Thorough Representation in the National Gallery: James Orrock.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of the Skull of a Carib, from a Cave in Jamaica: Prof. Flower, C.B., F.R.S.—Manners, Customs, Superstitions, and Religions of South African Tribes: Rev. James Macdonald.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Hawksbury Bridge, New South Wales: C. O. Purge.—The Erection of the Dufferin Bridge over the Ganges at Benares: F. T. G. Walton.—The New Blackfriars Bridge on the London, Chatham, and Dover Railway: G. E. W. Crutwell. (Discussion.)

ROYAL INSTITUTION, at 3.—The Post-Darwinian Period: Prof. G. J. Romanes, F.R.S.

WEDNESDAY, MARCH 12.

GEOLOGICAL SOCIETY, at 8.—On a Deep Channel of Drift in the Valley of the Cam, Essex: W. Whitaker, F.R.S.—On the Monian and Basal Cambrian Rocks of Shropshire: Prof. J. F. Blake.—On a Crocodilian Jaw from the Oxford Clay of Peterborough: R. Lydekker.—On Two New Species of Labyrinthodonts: R. Lydekker.

SOCIETY OF ARTS, at 8.—The Chemin de Fer Glissant, or Sliding Railway: Sir Douglas Galton, K.C.B., F.R.S.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 8.—Some Groups of Circles connected with Three given Circles: R. Lachlan.—Perfect Numbers: Major P. A. McMahon, R.A.

SOCIETY OF ARTS, at 5.—Agriculture and the State in India: W. R. Robertson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Theory of Armature Reactions in Dynamos and Motors: James Swinburne.—Some Points in Dynamo and Motor Design: W. B. Esson. (Discussion.)

ROYAL INSTITUTION, at 3.—The Early Development of the Forms of Instrumental Music (with Musical Illustrations): Frederick Niecks.

FRIDAY, MARCH 14.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—The Glow of Phosphorus: Prof. T. E. Thorpe, F.R.S.

SATURDAY, MARCH 15.

SOCIETY OF ARTS, at 3.—The Atmosphere: Prof. Vivian Lewes.

ROYAL INSTITUTION, at 3.—Electricity and Magnetism: Right Hon. Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Prodromus Faunæ Mediterraneæ, Part 2: J. V. Carus (Stuttgart, Koch).—The Elements of Laboratory Work: A. G. Earl (Longmans).—History of Botany (1530-1860): J. von Sachs; translated by H. E. F. Garnsey; revised by I. B. Balfour (Clarendon Press).—Traité Encyclopédique de Photographie, nouv. fasc.: C. Fabre (Paris, Gauthier-Villars).—A Syllabus of Elementary Dynamics: Prof. W. N. Stocker (Macmillan).—Synoptical Tables of Inorganic and Organic Chemistry: C. J. Leaper (Gill).—The Growth of Capital: R. Giffen (Bell).—Coal Gas as a Fuel: T. Fletcher (Warrington, Mackie).—The Zoological Record for 1888 (Gurney and Jackson).—An Elementary Treatise on Light and Heat, 2nd edition: Rev. F. W. Aveling (Relfe).—Demoids: J. B. Sutton (Baillière).—The Railways of Scotland: W. M. Ackworth (Murray).—Electrical Engineering: W. Slingo and A. Brooker (Longmans).—Un Viaggio a Nias: E. Modigliani (Milano, Fratelli Treves).—Transactions of the Astronomical Observatory of Yale University, vol. i. Part 2 (New Haven).—Cycles of Drought and Good Seasons in South Africa: D. E. Hutchins (Wesley).—How to Know Grapes by the Leaves: A. N. M'Alpine (Edinburgh, Douglas).—Boilers, Marine and Land, 2nd edition: T. W. Traill (Griffin).—Four-Figure Mathematical Tables, 2nd edition: J. T. Bottomley (Macmillan).—The Cultivated Oranges and Lemons, &c., of India and Ceylon, text and plates: Dr. E. Bonavia (Allen).—Elementary Manual of Magnetism and Electricity, Part 2: Prof. Jamieson (Griffin).—Quarterly Journal of Microscopical Science, February (Churchill).—Zeitschrift für Wissenschaftliche Zoologie, 49 Band, 3 Heft (Williams and Norgate).—Journal of the Royal Microscopical Society, 1889, Part 6a, 1890, Part 1 (Williams and Norgate).—Studies from the Biological Laboratory, Johns Hopkins University, vol. 4, No. 6 (Baltimore).—Transactions and Proceedings of the Botanical Society, vol. xvii. Part 3 (Edinburgh).—Annual Report of the Canadian Institute, Session 1888-89 (Toronto).

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